

TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS	iii
ABSTRACT (ENGLISH)	v
ABSTRACT (THAI)	viii
TABLE OF CONTENTS	xi
LIST OF TABLES	xvii
LIST OF FIGURES	xx
ABBREVIATIONS AND ACRONYMS	xxii
CHAPTER 1 INTRODUCTION	
1.1 Epidemiology of HIV infection	1
1.2 Nutritional status and HIV infection	2
1.3 The role of micronutrients on HIV infection	3
1.4 The effect of HAART on micronutrients status	3
1.5 The objectives of this study	4
CHAPTER 2 LITERATURE REVIEWS	
2.1 Immune system and HIV infection	
2.1.1 Immune system's response and pathology of HIV infection	5
2.1.2 AIDS definition	8

2.2 When to start highly active antiretroviral therapy (HAART) in HIV-infected patients

2.2.1 Guidelines to initiate HAART in Thailand 9

2.2.2 Other guidelines to initiate HAART 10

2.3 Micronutrients and the pathogenesis of HIV infection

2.3.1 Free-radical theory and HIV pathogenesis 14

2.3.2 Nutrition immunological theory and HIV pathogenesis 15

2.4 The role of micronutrients in human

2.4.1 Vitamin A

2.4.1.1 General information of vitamin A 17

2.4.1.2 Role of vitamin A on immune function 18

in HIV infection

2.4.2 Vitamin E

2.4.2.1 General information of vitamin E 23

2.4.2.2 Role of vitamin E as an antioxidant 24

in HIV infection

2.4.3 Vitamin B12

2.4.3.1 General information of vitamin B12 26

2.4.3.2 Role of vitamin B12 on immune function 27

in HIV infection

2.4.4 Zinc	
2.4.4.1 General information of zinc	31
2.4.4.2 Role of zinc as an antioxidant in HIV infection	32
2.4.5 Selenium	
2.4.5.1 General information of selenium	34
2.4.5.2 Selenium as an antioxidant in HIV infection	34
2.5 Micronutrients status in various populations	
2.5.1 Micronutrients status in healthy population	35
2.5.2 Micronutrients status in HIV-infected patients in pre-HAART	40
2.5.3 Micronutrients status in HIV-infected patients receiving HAART	47

CHAPTER 3 METHODOLOGY

3.1 Study design

3.1.1 Sample size, definition and calculation	56
3.1.2 Subjects inclusion criteria	59
3.1.3 Healthy subjects	60

3.2 Materials and Methods

3.2.1 Subject characteristics and food frequency dietary assessment	60
--	----

	Page
3.2.2 Serum collection	62
3.2.3 Laboratory methods	62
3.2.3.1 Determination of vitamin A and vitamin E in serum by high performance liquid chromatography (HPLC)	62
3.2.3.1.1 Quality control of serum vitamin A analysis	63
3.2.3.1.2 Quality control of serum vitamin E analysis	64
3.2.3.2 Determination of vitamin B12 in serum by Elecsys® vitamin B12 immunoassay	66
3.2.3.2.1 Quality control of serum vitamin B12 analysis	66
3.2.3.3 Determination of zinc in serum by flame-atomic absorption spectroscopy	67
3.2.3.3.1 Quality control of serum zinc analysis	67
3.2.3.4 Determination of selenium in serum by graphite-AAS	68

3.3 Statistical Analysis 69

CHAPTER 4 RESULTS

4.1 Characteristics of the studied subjects

4.1.1 Characteristics and demographic data of 70

HIV-infected subjects from 3 sources of recruitment

	Page
4.1.2 Characteristics and demographics of HIV-infected and healthy subjects	72
4.2 Micronutrients status in HIV-infected and healthy subjects	
4.2.1 Comparison of micronutrient status in HIV-infected and healthy subjects	75
4.2.2 Comparison of serum micronutrients status in HIV-infected and healthy subjects separated by gender	80
4.3 Correlations between CD4+ T cell counts and micronutrient concentrations	81
4.4 Food consumption patterns of HIV-infected and healthy subjects	83
4.5 Influence of food consumption pattern on micronutrients status of HIV-infected and healthy subjects	84
4.6 Influence of BMI, education, income status and alcohol consumption on micronutrients status of HIV-infected and healthy subjects	91
CHAPTER 5 DISCUSSIONS AND CONCLUSIONS	98
REFERENCES	105

	Page
APPENDICES	
APPENDIX A: AIDS defining symptom	117
APPENDIX B: Cronbach's alpha coefficient	119
APPENDIX C: Results of reliability for questionnaires by calculating Cronbach's alpha coefficient	120
APPENDIX D: Questionnaire form	122
APPENDIX E: Pattern of frequency food intake in HIV-infected and healthy subjects	128
APPENDIX F: Principle of High Performance Liquid Chromatograph (HPLC)	139
APPENDIX G: Method validation for serum vitamin A and E analysis by HPLC	141
APPENDIX H: Principle of Elecsys® Vitamin B12 Immunoassay	168
APPENDIX I: Determination of serum vitamin B12 by Elecsys® vitamin B12 Immunoassay	171
APPENDIX J: Principle of Atomic Absorption Spectroscopy (AAS)	175
APPENDIX K: Determination of serum zinc by Flame-AAS	178
APPENDIX L: Determination of serum selenium by GF-AAS	182
CURRICULUM VITAE	188

LIST OF TABLES

	Page
Table 2.1 AIDS surveillance case definition for adolescents and adults: 1993	8
Table 2.2 Guidelines to initiate GPO-vir (Thailand - 2004)	10
Table 2.3 Indications to initiate antiretroviral therapy-DHHS guidelines	11
Table 2.4 Indications to initiate antiretroviral therapy: IAS-USA guidelines-2004	12
Table 2.5 Indications to initiate antiretroviral therapy: WHO guidelines	13
Table 2.6 Vitamin A levels in serum or plasma of people from various countries	36
Table 2.7 Zinc levels in serum or plasma of people from various countries	37
Table 3.1 Inter-assay and intra-assay of serum retinol concentration in pool serum	64
Table 3.2 Inter-assay and intra-assay of serum α -tocopherol concentration in pool serum	65
Table 3.3 Inter-assay and intra-assay of serum vitamin B12 concentration in PreciControl Universal control material	67
Table 3.4 Inter-assay and intra-assay of serum zinc concentration in Lyphochek® Assay Chemistry Control	68
Table 3.5 Inter-assay serum selenium concentration in Seronorm™ Trace elements serum	69

	Page
Table 4.1 Characteristics of HIV-infected subjects from 3 sources	70
Table 4.2 Demographics of HIV-infected subjects from 3 sources	71
Table 4.3 Characteristics of HIV-infected and healthy subjects	73
Table 4.4 Demographics of HIV-infected and healthy subjects	74
Table 4.5 Comparison of vitamin A, E, B12, zinc and selenium status in HIV-infected and healthy subjects	78
Table 4.6 Comparison of micronutrients status in HIV-infected and healthy subjects separated by gender	80
Table 4.7 Food consumption pattern of rich source of vitamin A in HIV-infected subjects	85
Table 4.8 Food consumption pattern of rich source of vitamin A in healthy subjects	85
Table 4.9 Food consumption pattern of rich source of vitamin E in HIV-infected subjects	86
Table 4.10 Food consumption pattern of rich source of vitamin A in healthy subjects	86
Table 4.11 Food consumption pattern of rich source of vitamin B12 in HIV-infected subjects	87
Table 4.12 Food consumption pattern of rich source of vitamin B12 in healthy subjects	87

	Page
Table 4.13 Food consumption pattern of rich source of zinc in HIV-infected subjects	88
Table 4.14 Food consumption pattern of rich source of zinc in healthy subjects	88
Table 4.15 Food consumption pattern of rich source of zinc in HIV-infected subjects	89
Table 4.16 Food consumption pattern of rich source of selenium in healthy subjects	89
Table 4.17 Comparison of the mean scores of micronutrients derived from frequency of food intake between HIV-infected and healthy subjects	90
Table 4.18 Comparison of micronutrients status between HIV-infected and healthy subjects separated by BMI	92
Table 4.19 Comparison of micronutrients status between HIV-infected and healthy subjects separated by education	93
Table 4.20 Comparison of micronutrients status between HIV-infected and healthy subjects separated income status	94
Table 4.21 Comparison of micronutrients status between HIV-infected and healthy subjects separated alcohol consumption status	95
Table 4.22 Comparison of micronutrients status between HIV group with CD4+ T cell count < 200 and ≥ 200 cells/mm ³ separated by time of using GPO-vir	97

LIST OF FIGURES

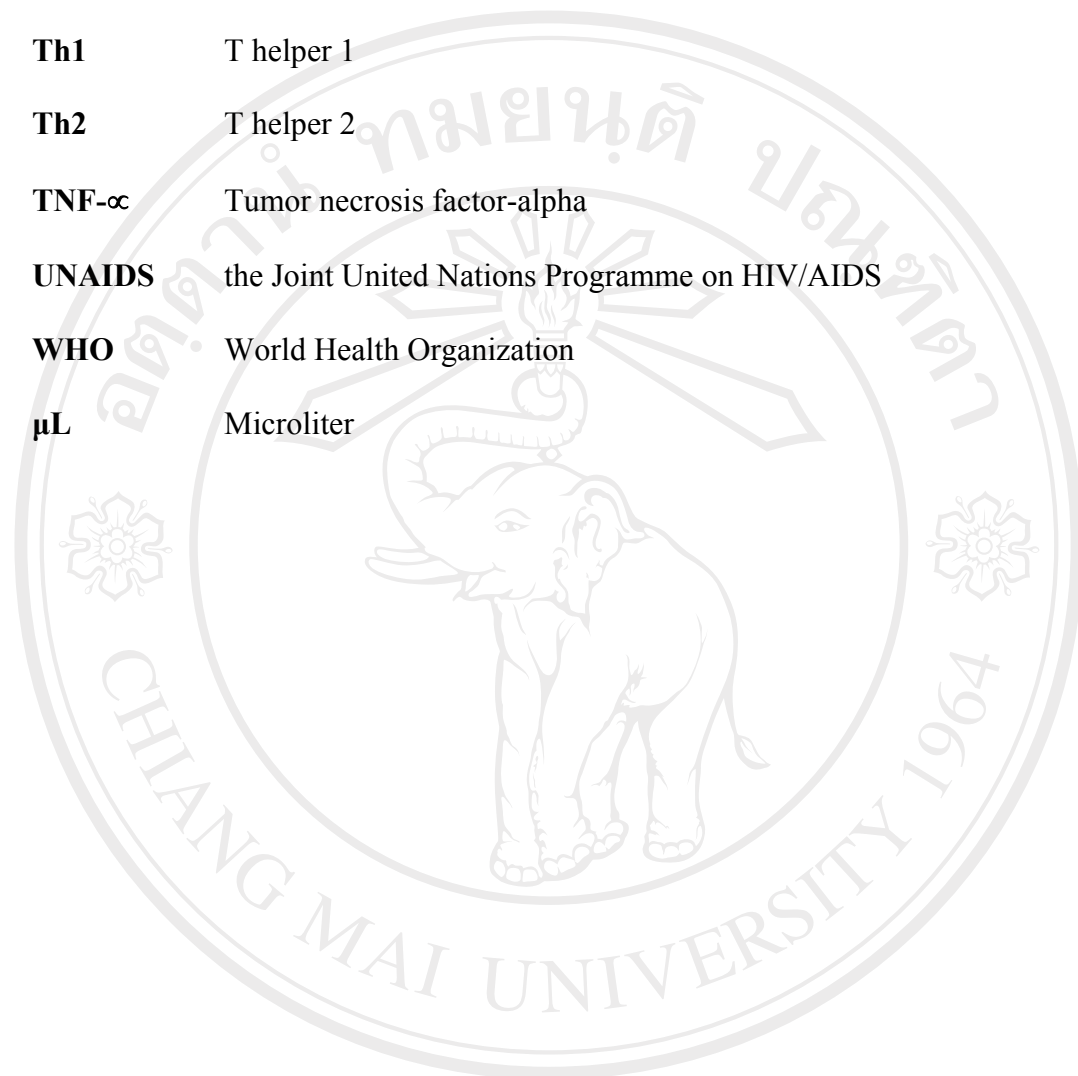
	Page
Figure 2.1 Comparison of activation, proliferation and differentiation of T-helper cells in healthy and T-helper cells in HIV infection	7
Figure 2.2 The generation of free radicals and antioxidant defense system in human body	16
Figure 2.3 A vicious cycle of HIV infection and oxidative stress	16
Figure 2.4 Structure of all- <i>trans</i> retinol	17
Figure 2.5 Vitamin A and mucosa Immunity	19
Figure 2.6 Effects of vitamin A deficiency and of retinoic acid on cytokine production on mechanisms of immunity	20
Figure 2.7 The illustrates three mechanisms by which infections are know to impair vitamin A status	22
Figure 2.8 Structure of α -tocopherol	23
Figure 2.9 The improvement of immune dysfunction by vitamin E	25
Figure 2.10 Structure of vitamin B12	26
Figure 2.11 Metabolism of methionine	29
Figure 2.12 Metabolism of methylmalonyl CoA	30
Figure 2.13 Propose mechanisms of zinc stabilization of sulfhydryl groups in enzyme δ -aminolevulinic acid dehydratase	33

	Page
Figure 2.14 Enzymatic and non enzymatic free radical defense system	33
Figure 4.1 Distribution of serum vitamin A (A), vitamin E (B) vitamin B12(C), zinc(D) and selenium(E) concentrations in HIV-infected and healthy subject	77
Figure 4.2 Correlation of CD4+ T cell counts with concentration of serum vitamin A (A), vitamin E (B), vitamin B12(C), zinc(D) and selenium(E)	82

ABBREVIATIONS AND ACRONYMS

3TC	Lamivudine
AAS	Atomic Absorption Spectroscopy
AIDS	Acquired immunodeficiency syndrome
BMI	Body Mass Index (kg/m ²)
CD4	Cluster of differentiation 4, main target cells for HIV, the number of which decreases during HIV infection
d4T	Stavudine
GPO	The Government Pharmaceutical Organization
HAART	Highly Active Antiretroviral Therapy
HPLC	High Performance Liquid Chromatography
HIV	Human immunodeficiency virus
mL	Milliliter
NAPHA	National Access to Antiretroviral Programs for PHA
NF-kB	Nuclear factor kappaB
NNRTI	non-nucleoside reverse transcriptase inhibitor
NRTI	Nucleoside Reverse Transcriptase Inhibitor
NVP	Nevirapine
PIs	Protease Inhibitor
RDA	Recommended daily allowance
ROS	reactive oxygen species
IFN-γ	Interferon-gamma

IL	Interleukin
Th1	T helper 1
Th2	T helper 2
TNF-α	Tumor necrosis factor-alpha
UNAIDS	the Joint United Nations Programme on HIV/AIDS
WHO	World Health Organization
μL	Microliter



ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่
Copyright© by Chiang Mai University
All rights reserved